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Oak trees are elemental carbon sinks in urban ecosystems: patterns and drivers

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Cities represent a significant source of atmospheric elemental carbon (EC), a minor constituent of particulate matter (PM) but a major climate-forcing agent and air pollutant. Urban trees scavenge PM and regulate material fluxes to the ground. As such, urban trees represent potentially important sinks—not only for PM but also for EC—in urban landscapes. Here we assess the magnitude and spatiotemporal drivers of EC removal by trees in urban atmospheres. We quantified foliar EC accumulation by, as well as throughfall EC flux under, the canopy of two oak species (*Quercus stellata*: post oak; *Quercus virginiana*: live oak), which are widespread across the southern United States. Sampling was conducted from March 2017 to March 2018 across the City of Denton, a city at the northern edge of the Dallas-Forth Worth metropolitan area in Texas. Over the year-long study period, we found that post oak tree canopies accumulated two times more EC (0.53 mg EC m^{-2} leaf d^{-1}) than live oak trees (0.22 mg EC m^{-2} leaf d^{-1}), with 95% of EC depositing to leaf surfaces as opposed to leaf waxes. Throughfall EC fluxes were also greater under post oak (0.15 mg EC m^{-2} d^{-1}) compared to live oak (0.12 mg EC m^{-2} d^{-1}) canopies, but these differences between post oak and live oak were far less pronounced than for foliar EC accumulation. These results suggest that considerable amounts of dry-deposited EC are retained in post oak canopies, reducing species differences in throughfall EC fluxes. Our findings also revealed strong, albeit, contrasting seasonal patterns for foliar EC accumulation and throughfall EC fluxes. For both tree species, EC accumulation on canopy surfaces increased, whereas throughfall EC fluxes decreased from spring to fall, providing additional evidence that EC retention on canopy surfaces results in decreased EC fluxes to the ground. In summary, our findings show that urban oak trees scavenge considerable amounts of EC from the atmosphere and that the magnitude of accumulation and delivery to soil vary by species and season. This research highlights the potential for urban trees and forests to contribute to climate and air quality mitigation.